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AQUATIC LIFE

Fishes, Shell Fish, Reptiles,

And their Life History.

HOME TEACH MANUALS

No. 16.

BY

FRANK OWEN PAYNE,

"Author of One Hundred Lessons in Nature," etc.

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"How to Teach" Manuals.—No. 16

HOW TO TEACH ABOUT AQUATIC LIFE

FISHES, SHELLFISH, REPTILES, AND THEIR LIFE-HISTORY

BY

FRANK O. PAYNE

AUTHOR OF "ONE HUNDRED LESSONS IN NATURE," "HOW TO TEACH ABOUT TREES," ETC.

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HOW TO TEACH ABOUT AQUATIC LIFE.

CHAPTER I.

Introductory.

IN beginning the study of the various forms of life which are found in water, one discovers that they are as various and as different as those which live in the air. Indeed one is often led to think that water-creatures are more variable and more wonderful than the inhabitants of the air. This is not the truth. They seem curious because we are not familiar with them. But they are no more so than are the creatures with which we are most familiar. All living things are wonderful. Nay more, all created things are wonderful. It is not for man to say which of all God's works is most so.

But whether we study life in the water or out of it, one fact belongs to all living things: All breathe. And it is due to their different manner of breathing

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that the water-creatures as a class are different from those of the air.

All living things have a circulating fluid (sap or blood) which carries nutriment to the growing parts and removes worn-out particles from wasting tissues. This fluid must be purified in order to do its work and oxygen must be absorbed in order to make it pure.

Now, the real difference between air-breathing and water-breathing creatures lies in the way that this oxygen is received into the blood.

Air-breathers have lungs; water-breathers have gills.

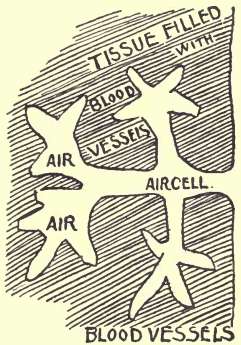

FIG. 1.—Lung-cell.

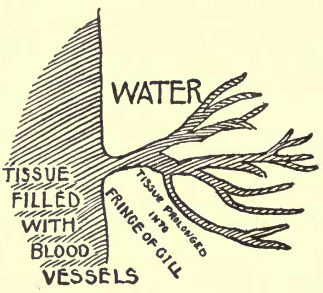

FIG. 2.—Gill Fringe.

Now, lungs and gills do not seem to be very much alike, but on close observation their difference is not so great as would at first appear. A gill may be considered as a lung turned inside out. In order

that the blood may absorb oxygen, it must come into direct contact with it. Now, in a lung-cell the blood flows on one side of a very thin membrane while pure air is on the other side, and the oxygen and carbonic acid gas pass through this membrane, the former to the blood and the latter from it.

Now, it would be too great an effort to inhale water; so the membrane is extended outward, bringing the blood into direct contact with the pure water, and the oxygen and carbonic acid gas are exchanged as before.

CHAPTER II.

How to Study Water-life.

THERE are two ways of studying the creatures which live in water. These may be known as the out-door way and the in-door way. To these may be added a third method, but as the writer has little use for it, it will be dismissed with a very few words. I allude to the study of preserved specimens.

Now, it cannot be denied that dried and pickled specimens have their place. The place of all such things is the same as that of reference books in a library. They are useful principally for reference. But the study of such things is to be discouraged if fresh material is to be had, and by fresh material is meant live specimens when these are at hand.

Of the two methods above more may be said.

1. By the out-door method is meant the observation of water-animals in their own environment. Surely nothing can be more delightful than to sit by the side of a brook and to watch the fishes as they dart hither and thither through the limpid

water. The fact that the student sits at the end of a fishing-rod need not hinder his enjoyment either.

To row out upon the surface of a shallow pool and then to lie at full length and scan the transparent depths below may look like the acme of indolence, but to the lover of nature it is not so. What tragedies, what comedies, what histories are enacted and repeated in those cool depths only they who have witnessed them may know.

2. But every teacher cannot do so. The streams and pools with their teeming life cannot be visited by the whole school and out-door observation must ever be largely an ideal not easily to be attained. So if the school cannot go to the pond, the pond at least can come to the school. That is, a sample of the pond can come to the school in the shape of an aquarium. Indeed in many respects the aquarium is the most satisfactory way for studying the forms of life which inhabit water.

It is small, convenient, and movable. The contents can be changed at will. The time required to go to a pond or stream is saved by having the aquarium in the room. Lastly, the aquarium is present for a long time. It is ready to be seen at any moment, and changes requiring many observations may be seen at odd moments without detracting from class exercises in other subjects.

CHAPTER III.

How to Make an Aquarium.

THERE are two forms of aquarium. One consists of a glass vessel into which living animals are put for study or ornament and in which there is nothing else but water. Such an aquarium requires much attention, for the water must be changed once or twice per day, and even with these precautions animals can rarely be made to live long in such environment. Indeed one is strongly inclined to declare that such a thing is in no sense an aquarium.

The better form of aquarium may be called the self-sustaining aquarium. It is so called because it contains the right amount of plants and animals mutually to satisfy each other.

It is well known that the very substances which animals breathe out, plants require, and *vice versa;* so that if an aquarium is stocked with both plants and animals, both will thrive equally well. Let it not be supposed that an aquarium must be of any special shape or size. Any vessel of clear glass of

any size or shape will do, but vessels having straight faces and square angles are greatly to be preferred.

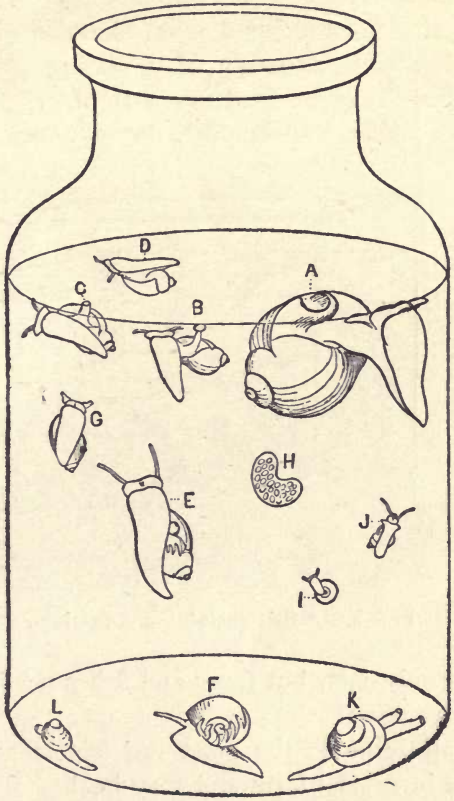

FIG. 1.—Glass Bottle used as Aquarium.

The least desirable form of vessel is the common globe. Its convex shape causes everything within

to appear magnified so that observations cannot be relied upon any more than one's own image seen in a convex or a concave mirror.

The size must depend upon the size of the inhabitants. An aquarium for rearing gnats and mosquitoes may be made in a tumbler. Dragonflies, stone-flies, and crayfish do very well in quart

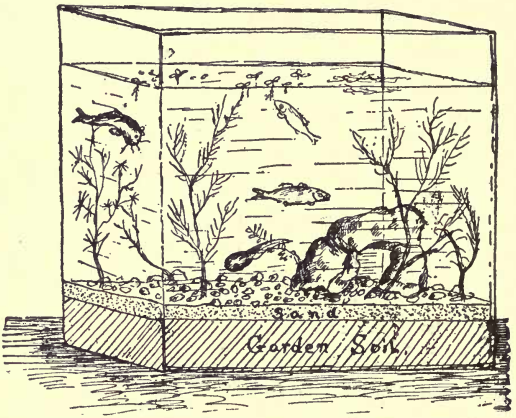

FIG. 2,—A Self-sustaining Aquarium.

jars or candy-jars, but frogs and fishes need a great deal more room.

For all purposes the most satisfactory aquarium is made in cubical form and may be had from any dealer in apparatus.

Having selected a suitable jar the next step is to stock it. It is not difficult to stock an aquarium,

but it is not always easy to secure inhabitants who will live peaceably in it together. The weaker and smaller creatures often become the prey of the larger ones, so that what sometimes is, in the start, a very thrifty looking colony is reduced in a few days to one or two individuals.

1. Place a layer of clean coarse sand or fine gravel on the bottom of the vessel. This is to form an anchorage for the roots of the water-plants. These may be collected at the same time that the animals are procured. A very good way is to prepare the vessel with soil and plants, add the water slowly, and allow to stand until the water has become clear. Then place the animals in the dish. Caution: Do not have too many of either plants or animals. The proper balance can only be determined by experiment.

2. Do not try to compel creatures to live in an aquarium if they do not naturally belong there. The writer once saw an aquarium in which a tree-toad was making desperate attempts to escape. Let it be remembered that many forms of animal life pass their infancy in water, but when they reach maturity they live in the air.

3. Attend to the amount of light and heat. If possible, never let the temperature rise above 50° Fahr., nor below 35°. Never let an aquarium be exposed for very long in the direct sunlight; a shady place is much to be preferred.

4. An aquarium must be aired from time to time also, for the plants contained are not sufficient for all purposes. It is also an excellent idea to put some fragments of charcoal in once in awhile. These will deodorize the water if any foulness has arisen through the death and decay of any of the inhabitants.

5. Always provide a supply of water-snails. These creatures are herbiverous, and their food is mostly the green slime which accumulates so abundantly on the glass if these animals are not provided.

6. Let it be urged as a suggestion that sea-shells, specimens of coral, and all sorts of impossible caves be omitted from these aquaria. There is something inexpressibly ridiculous about corals, sea-shels, and all such things lying in fresh water among creatures with whom they could not possibly have had any connection.

Before concluding this chapter it may be helpful to describe how to catch water-animals without the risk of injuring them. An ordinary dipping-net made by fastening a piece of thin netting over a hoop fastened to a long stick. This will do in deep water, but in shallow places a long-handled dipper or indeed an old tomato-can may be made to answer very well. Nor will one have to go far or wait long before making many captures. Last spring the writer caught five different sorts of living creatures

without moving one step in a little stream half a mile from his home.

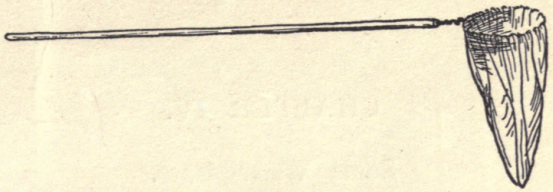

FIG. 3.—An Ordinary Dipping-net.

CHAPTER IV.

Some Water-plants.

In this chapter we will study some of the plants which live in water and which may be grown in the aquarium. These are Duckweed, Eel-grass, Nitella, Chara, and Potamogeton.

These plants are particularly interesting on account of the great quantities of oxygen which some of them give off if placed where the sunlight falls upon them. In fact the writer has often caught vessels of oxygen by inverting over these plants a jar filled with water.

1. **Duckweed** (Fig. 4). — This curious little plant is also called "duckmeat." It grows abundantly in quiet water where its small clusters of round green leaves float upon the surface. If examined there will be found a fine cluster of delicate threadlike roots projecting downward from the under surface into the water. The leaves are bright green in color and rather thickish. If cut open they will be found to be made of a spongy, cellular substance full of air spaces. By means of these they

are able to float. A small amount of Duckweed should be placed in every aquarium, but not too

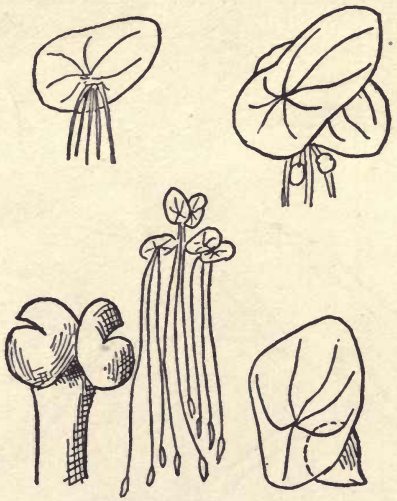

FIG. 4.—Duckweed.

much, since it prevents a good view from above if very much of this plant is floating on the surface.

2. **Eel-grass** (Fig. 5).—Eel-grass is very different from Duckweed. It grows to the bottom and has long slender thin leaves. The most remarkable peculiarity is the way it takes to bring its flowers to the surface of the water. There are flowers of two sorts on this plant. One sort of flowers has the stamens and the other the pistils. Now, there are no bees or other flying creatures under water to

take the pollen from one kind of flowers and bear it to the pistils of the other sort, so nature does a very curious thing. When the staminate flowers are ripe they break off from the parent stem and

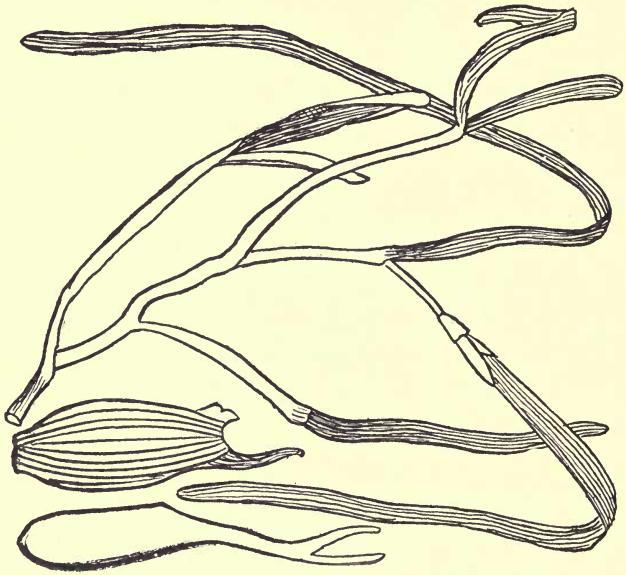

FIG. 5.—Eel-grass.

rise to the surface. Here they open and cast their pollen on the water. But the pistillate flowers do not propose to be deprived of their pollen, so they stretch their stems until their flowers also reach the surface. To do this nature has given to these flowers a long slender spiral stem (peduncles) so that

they can expand like a spiral spring. When the fertile flowers have received the pollen, their spring-like stems contract and they can then ripen their fruit under water. Eel-grass is also known as tape-grass on account of its long tape-like leaves. In the regions above the Chesapeake Bay it is aleo known as "wild celery," where it is the favorite food of the canvas-back duck.

Eel-grass is an excellent plant for aquaria. Its interesting habits above described make it most interesting to observe.

3. **Water-weed** or **Ditch-moss** (Fig. 6) is also a good plant for aquaria. The stems are submerged and quite long, branching and very leafy. The leaves are linear, opposite, or whorled, and are crowded closely together. Each leaf has a simple vein or nerve through the middle. The flowers are rarely seen, but like the eel-grass they are of two kinds and they are fertilized in much the same way. The fertile flower is not possessed of a spiral stem like that of the eel-grass, but it reaches the surface by the elongation of the calyx-tube. Ditch-moss has a rich green color and forms a most desirable addition to any aquarium. If exposed to the direct rays of the sun, the leaves will soon become covered with bubbles of oxygen which glisten like dew-drops in the light.

4. **Potamogeton** or **pondweed** (Fig. 7) is hardly desirable in small aquaria on account of its size, for

it often attains a growth many feet long. But it is an interesting plant to observe, and pieces of it may be placed in small aquaria.

FIG. 6.—Ditch-moss.

There are many species of pondweed, but the commonest may be known by its bright green, oval, floating leaves and by its narrow submerged ones.

The flowers are small, green or red, and clustered in spikes. These spikes, especially in their fruit, usually project above the water of quiet pools and inland lakes.

Whether pondweed be placed in the aquarium or not, it is a good thing for teachers to be able to

FIG. 7.—Pondweed.

know it, for in summer the under surface of its floating leaves will usually be found covered with minute animals such as amœbæ, hydræ, etc.

Water-lily leaves are also good places to look for the lower forms of fresh-water life.

5. **Hornwort** (Fig. 8).—This beautiful aquatic plant may be known by its numerous slender

branching stems and its whorls of narrow leaves. It floats in the water, bearing flowers of both kinds which are very small indeed. The flowers depend on currents of the water to fertilize them.

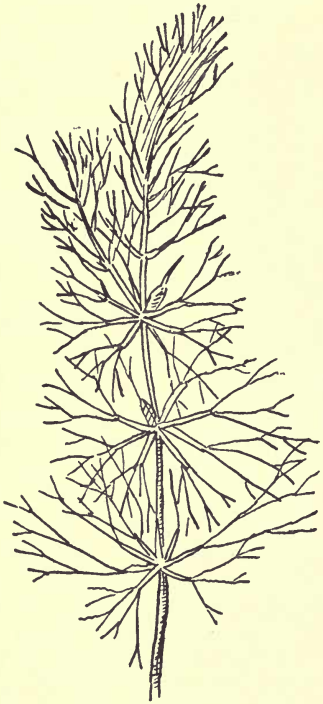

FIG. 8.—Hornwort.

FIG. 9.—Water-wort.

6. **Water-wort** or **mud-purslane** (Fig. 9) is so called because its leaves have a slight resemblance to the purslane of "pusley" of the gardens. It

grows in small clusters or tufts in very wet places, being sometimes under water and at others well out of it. The stems are stout and short and the leaves thickish. The flowers are sessile in the leaf-axils and very minute. A small tuft of this plant looks well in the bottom of an aquarium.

7. **Water-nut** or **water-milfoil** is a tropical plant which thrives well in aquaria. The leaves are of

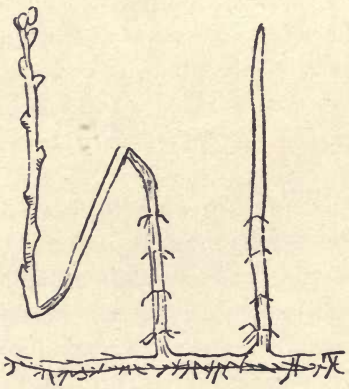

FIG. 10.—Water-nut.

two kinds, the much dissected submerged ones and the broad egg-shaped aerial leaves. This plant floats by means of its inflated leaf-stems. These are enlarged and filled with air. Thus the plant floats with its lower leaves in the water and its roots in the mud. It can only be had at the greenhouses,

and for that reason is not so desirable as our native aquatic plants.

8. Chara or stonewort.—The mode of growth of this plant and especially its mode of flowering or reproduction is too complicated to enter into a book of this kind, but the plant itself is a desirable one for the aquarium.

It grows in fresh and in brackish water, where it forms in great masses over the bottom. The stems are long, cylindrical, jointed, and much branched. The branches give off whorls of thick needle-shaped leaves and the whole plant is covered with a crust of lime which makes it rough and harsh to the touch. This lime makes the plant very brittle, hence the name stonewort.

Chara is of a dull green color bordering on olive. It looks very pretty in an aquarium.

9. Water-cress grows well in a shallow aquarium. It is too well-known to need a description. It is the well-known cress used as a salad and sold in the markets. Its peppery taste proclaims its near relationship to mustard and horseradish.

10. Green-slime. The foregoing nine plants are valuable in an aquarium, since they take up the carbonic acid gas given off by the animals and give off oxygen, without which the latter cannot live. But whether you desire it or not, you are sure to have a most undesirable guest in the form of a plant known as green-slime. This grows on

FIG. 11.—Chara.

the glass and also on the rocks within, and unless it is removed the glass will become so thickly coated with it as to prevent observations.

But nature has provided a way of removal which

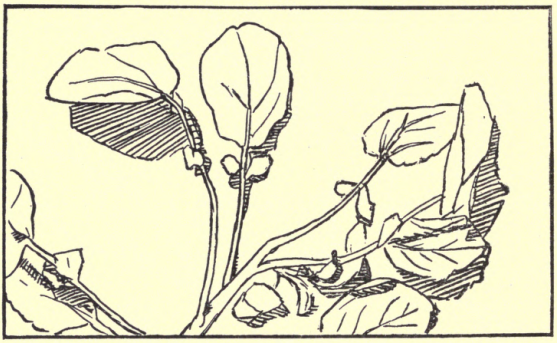

FIG. 12.—Water-cress.

is as interesting as it is instructive. Among the creatures that live in the water are many which live on green-slime. These are the water-snails. No aquarium is complete without a few of them. They will be studied in the second part of this book.

CHAPTER V.

Some Water-animals.

THE animal life of the water may be divided into three classes. These are first those whose whole life is spent in the water; second, those whose early life is spent in water but whose mature life is spent out of it; and third, those who at certain times take to the water while at others live on the land.

To the first class belong all hydras, most fishes, and certain species of snails. To the second class belong many insects such as the mosquito, dragon-fly, and corydalis. To the third class belong the frogs, toads, newts, and some turtles, or what are commonly classed as amphibrians.

It will be the purpose of the next few chapters to study some of these creatures.

1. **Fishes.**—Select some fish, no matter what kind of a fish it is, and study it as a type. Having made a thorough study of one fish, others will be more easily observed.

Observe (*a*) parts (head, body, and tail); (*b*) fins (one or two dorsal, two ventral, two pectoral, one

anal, and one caudal); (*c*) gill-covers; (*d*) mouth; (*e*) covering.

Not all fish are possessed of all the fins mentioned

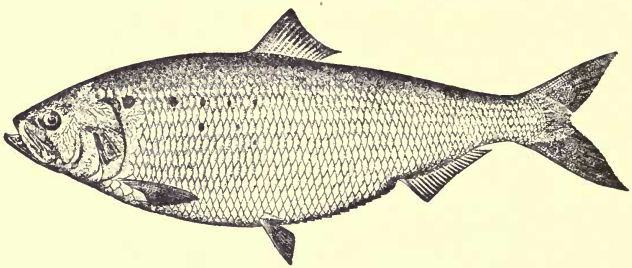

FIG. 13.—Shad.

above, but all have pectoral and ventral fins. These represent the upper and the lower extremities. Most fishes have three other fins. These are one dorsal, one anal, and one caudal fin.

Observe the fish to discover how he swims. It

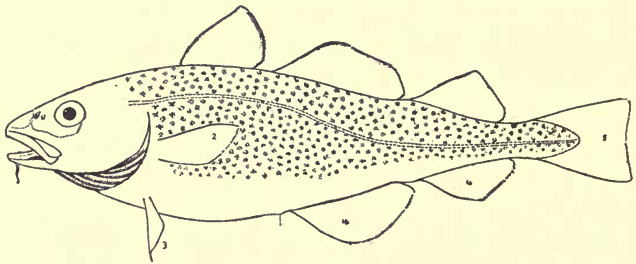

FIG. 14.—Cod.

will be seen that it is due to the motions of the caudal fin from side to side, just exactly as an oarsman propels his boat with a single paddle astern,

and not to any action of the lateral fins. These serve to balance the body in the water.

Next study the gill-covers. These are the broad, rounded, horny plates on each side of the head back

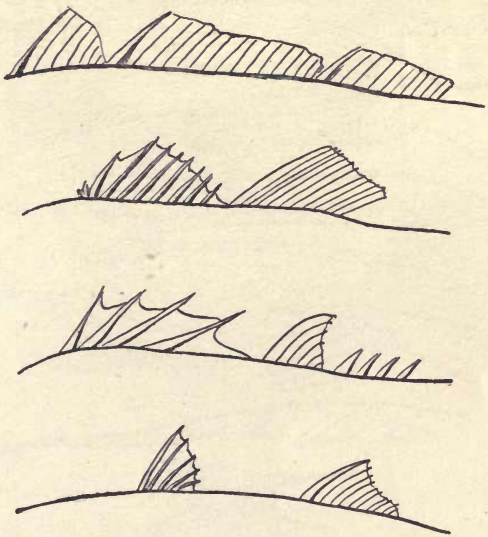

FIG. 15.—Dorsal.

of the eyes. These are often called gills. The real gills are soft red fleshy fringes arranged in rings or arches underneath the gill-covers. The mouth and the manner of breathing should be observed. Notice that the mouth opens as the gill-covers close and *vice versa*. In this way the water entering the mouth passes back over the gills, washing

them and supplying them with oxygen at the same time that it carries away the impurities.

Fishes do not drink. What appears to be drinking is really breathing.

Examine the covering of the fish. Most fishes

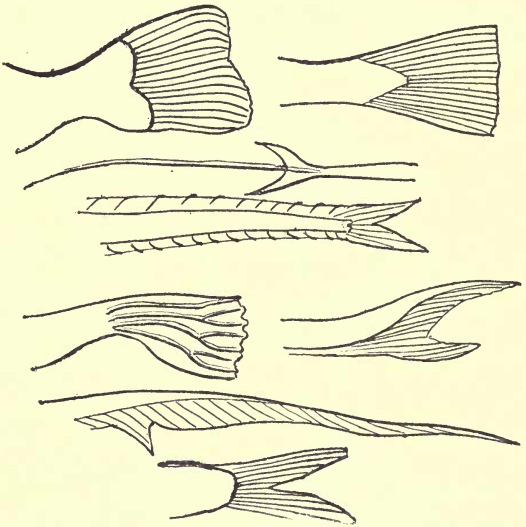

FIG. 16.—Caudal Fins.

are clad in an armor of shining scales which overlap very much as shingles overlap on a roof. But some fishes have no scaly covering, as may be seen by studying trout, catfish, and eels. In others the scales are so small as to be scarcely visible. The scales of the pike and the trout are very small indeed.

The fins and tails vary greatly in structure and in form. A few forms are submitted.

GOLDFISH.

Goldfish are so common in aquaria that we shall first consider them. They are very variable in size, some attaining a length of fourteen inches and

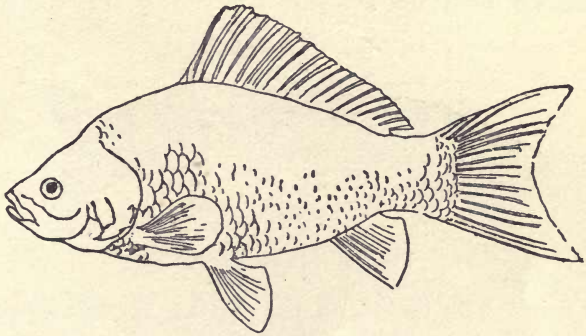

FIG. 17.—Goldfish.

weighing over two pounds. They are usually of a deep red-orange color, but it is not unusual to find them almost white or black and variously mottled.

Goldfish are easily raised. They thrive very well in confinement, and accustom themselves to ponds very easily. At Glen Cove, Long Island, the ponds were stocked years ago with goldfish and they are still very numerous there. They may frequently be seen swimming in schools through the water.

Brook-trout.

These fishes do not thrive well in aquaria, since they need fresh running water. Indeed any one who is familiar with the habits of brook-trout knows that their favorite haunt is where the water rushes over and among the stones.

It is difficult to describe adequately this beauti-

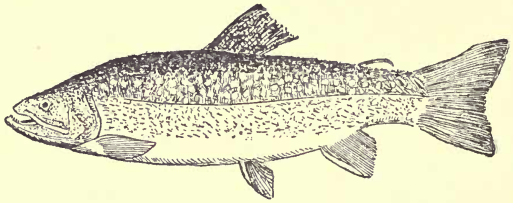

Fig. 18. —Brook-trout.

ful fish. The male and the female are about the same size, being about a foot long and nearly four inches deep, and sometimes weighing over four pounds.

The male is white along the belly and colored with bands of orange, olive, and dusky gray at the dorsal side. The upper portions of the body are variously spotted and speckled, and there are several scarlet dots bordered with blue along the sides.

The female is much paler than the male, being white below and having no orange band.

The pectoral fins are placed low and there are two dorsal fins, the hinder one being very small.

The ventral, pectoral, and anal fins are tinged with orange or scarlet.

On the whole, the trout is a very beautiful fish. Its appearance is quite in keeping with its reputation for gameness.

SUNFISH.

These are small flat oval-shaped fishes variously marked with red, blue, gold, green, and black.

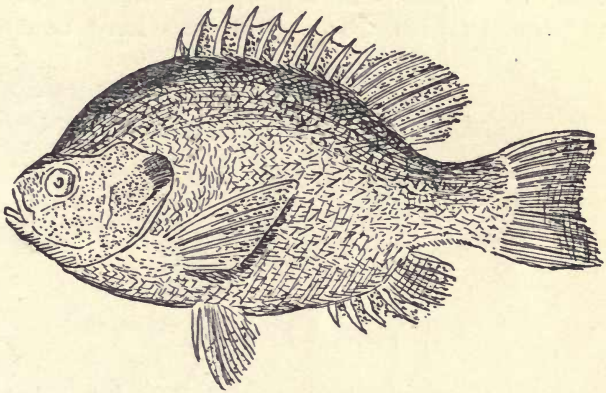

FIG. 19.—Sunfish.

They abound in fresh-water lakes and streams and are often called "pumpkin-seeds" because of their shape and small size. They are rarely over four or five inches long. But although they are very bony they are excellent eating. In an aquarium sunfish sometimes show signs of sickening. This may be due to a fish-disease caused by growth of a fungus.

It has been found that if salt water be added slowly until the whole is brackish, these fungi are killed without any injury to the fishes. After a time the water may be gradually replaced with fresh water.

Black Bass.

This fish is reputed to be able to change its color. Whether this be true or not, they vary greatly in color, having black, green, or yellow sides according to circumstances. The gill-covers have two flat

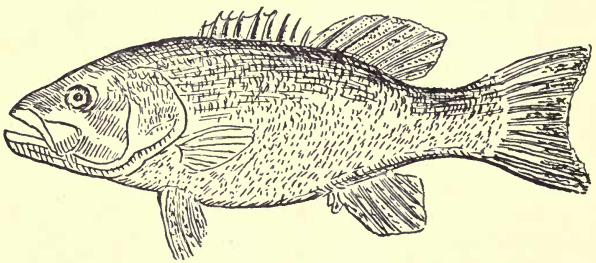

Fig. 20.—Black Bass.

points and minute teeth. The back fin is single but partly divided into two with ten hard and fourteen soft rays. Pectoral fins have eighteen soft rays, ventral fins six soft rays, and anal fins three spines.

The black bass belongs to the perch family. They take all sorts of bait, but prefer live to dead bait. The helagramite is a favorite bait. In June they frequent grassy bottoms. Later they are found among rocky shoals.

YELLOW PERCH.

These fishes abound in northern waters. They are yellow in color, having several dark vertical bars over the back. Fins orange. Gill-covers are toothed below and armed with long spine. Teeth

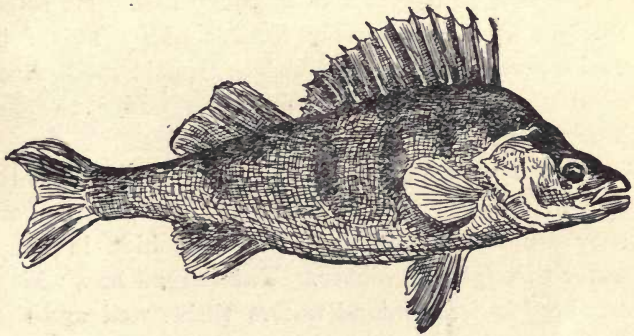

FIG. 21.—Yellow Perch.

small. The fin-rays are as follows: Dorsal, 13, 2, 15; ventral, 1, 5; anal, 2, 8; caudal, 17.

The yellow perch spawns in April and May near the shore usually in water one foot deep. The flesh is coarse white, tasteless. They probably destroy multitudes of young trout.

STRIPED BASS.

This fish is a favorite with fishermen. It is bluish on the back, lighter on the sides and white on the belly. Its name is due to the presence of

from seven to nine dark lines which traverse the sides of the body. Those on the upper side extend to the tail, while those on the ventral side fade out. The gill-covers are rough like the edge of a saw. They have two spines on the back. The ventral fins are lower and behind the pectorals.

The striped bass is a very gamey fish. He bites freely and fights bravely for his life. This fish varies greatly in size and weight, specimens having been captured weighing from one ounce to one hundred pounds.

Striped bass spawn in April, running up rivers to spawn. They return to salt water in autumn, when they are said to burrow in mud or hide in deep water through the winter. The striped bass which are bred in fresh inland waters thrive well and the flesh has a better sweeter flavor.

Catfish.

This fish is familiarly known as the bullhead. It is also called the horned pout because of the numerous fleshy tentacles arranged about the mouth. These give these fish a formidable appearance.

It is common in fresh water east of the Rocky Mountains. It is black on the back and white on the belly and its head is very large in proportion to the remainder of the body.

The catfish is very voracious, eating everything. It is very tenacious of life also. In spring the cat-

fish spawns and the female is said to watch the young.

Catfish frequently attain to an enormous size and weight; one huge catfish in the New York Aquarium

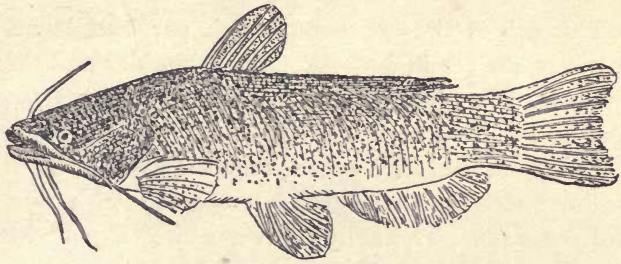

FIG. 22.—Catfish.

is said to weigh over 200 pounds. Such fish are very fat and the flesh is very strong and unfit for food. Young fishes, however, are most delicious eating, as the flesh is delicate in flavor and fine in texture.

They are prepared for the table by skinning. The skin is easily removed and is very tough.

WHITEFISH.

This is one of the handsomest and most useful of American fishes. As the name indicates, this fish is nearly white, being colored a bluish gray only on the dorsal aspect. The scales are large, teeth minute velvet-like, body narrow compressed, mouth very small. This fish abounds in the Great Lakes, where it is caught in great numbers. It often

weighs from twelve to fourteen pounds and is the finest fresh-water fish.

TROUT.

This fish is the sportsman's fish par excellence. It never thrives in aquaria. The shoulder and the first dorsal fins have eleven rays, the ventral eight, anal fifteen, and caudal nineteen.

The back is dusky green, mottled with brilliant yellow spots on the sides, interspersed with blue and red dots. The belly is silver-white tinged with rose-color. The body appears at first to be naked, but on close examination it is seen to be covered with very minute scales. The tongue and throat are covered with teeth. The trout prefers the limpid waters of a brook, where he may swim about among the rocks. As an article of food no fish surpasses the trout in delicacy of flavor.

2. Mollusks or Shellfish. Snails.—These creatures may be divided into two great groups depending on the number of their shells. These are univalves or mollusca having one shell and bivalves or mollusca having a pair of shells joined by a hinge and fitting closely together.

The commonest fresh-water mollusks are the snails, and of these there are many species. We will consider only two of the common forms, because both are readily found creeping over rocks and

submerged stems in their search for tender green-slime, which forms their principal food.

Their shells are of two general forms, the spiral (*a*) and the conical (*b*). In various species the shell varies between these forms and these animals vary in size from very tiny creatures scarcely larger than a pin-head to more than an inch in diameter.

Wate-rsnails are not water-breathers. They have no gills, but they have the simplest form of lung.

FIG. 23.—Snails.

To prevent the entrance of water the nostril closes with a lid. If watched for some time water-snails will be seen to go to the surface and thrust the head above it. This is to breathe. If a plant or bit of rock project above the water, the snails will often go up and remain for some time in the air.

If green-slime is growing upon the glass of the aquarium, water-snails will soon be found crawling over it and their manner of locomotion can easily be observed. The portion which they thrust from the shell is called the foot. It is a soft muscular

body and it acts like the ordinary leather "sucker" in holding the snail to the glass. If observed closely the wave-like vibration in this foot will be seen as the snail advances across the glass.

Pond-snails are unlike land-snails in having no eye-stalks. Their eyes are located at the base of their feelers.

Fresh-water Mussels.

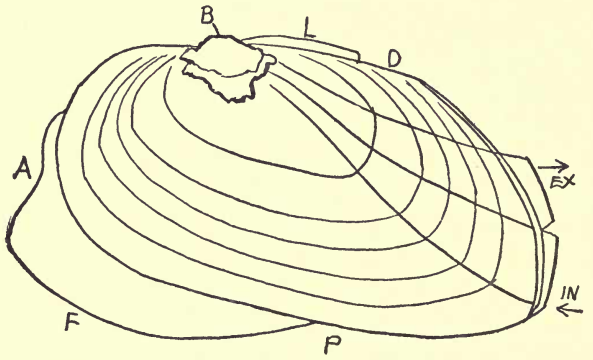

Diagram of Fresh-water mussel: L. ligament; b. beak; f. foot; ex, excurrent orifice; in, incurrent orifice; p. posterior; d. dorsal; v. ventral.

Fig 24.—Diagram of Fresh-water-mussel Shell.

Over the bottoms of fresh-water ponds one may often see long lines or scratches in the soft mud.

These marks look not unlike the tracks made across muddy road-beds at night by the familiar earth-worm or angle-worm. If followed with the eye for some distance a fresh-water mussel will usually be found with its hinge-line uppermost. The track has been made with its tough fleshy foot.

The mussel-shell is broad and convex. The lines of growth are very plain. The shell is covered with a horny layer of a dull olive-brown color. Within the shell is pearly and shows several muscular impressions. There are several species of mussel, some having very beautifully colored shells.

CLAMS.

Clam-shells resemble those of the fresh-water mussel somewhat in shape and size, but they are

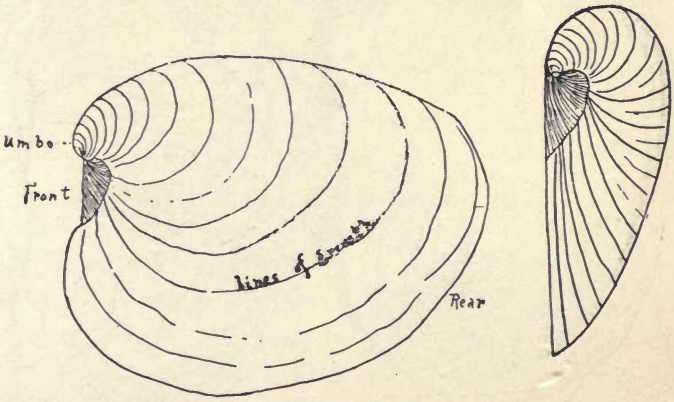

FIG. 25.—Clam-shell—Exterior View.

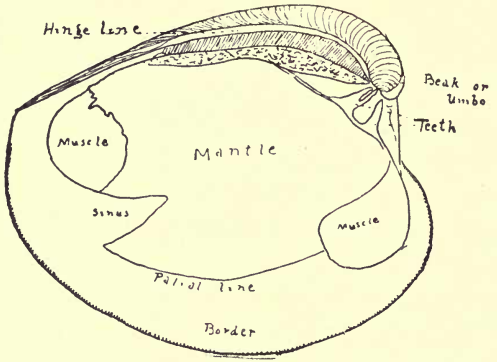

FIG. 26.—Interior View of Clam Shell.

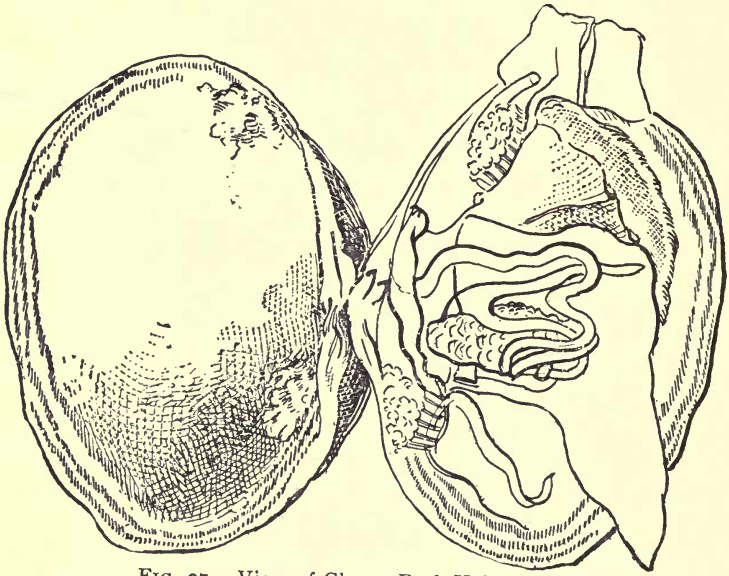

FIG. 27.—View of Clam—Both Valves Open.

thicker, heavier, and whiter in color. The lines of growth also are more prominent. There is no horny growth on the outside of clam-shells. The inner surface of the valves shows only two muscular impressions. The inside is also smooth but not pearly, and the lines of growth are not to be seen. Near the edge of the clam-shell is a well-marked line, just as there is in the fresh-water-mussel shell, but in the latter it is parallel with the edge, while in the former this line bends inward, forming a deep notch.

Clams bury themselves in the sand at the sea-bottom, whence they are brought forth by means of long-handled tools known as clam-tongs. Unlike the fresh-water mussel, clams do not travel. Soft-shell clams resemble the foregoing. They are dug out of the sand at low tide.

The clam is a good creature to study as a type, since it stands at the head of the class among animals.

SCALLOPS.

These are well known on account of their great delicacy and beautifully shaped shells. Scallops, unlike the preceding mollusks, do move about, and that very rapidly. They do this by means of opening and shutting their valves. This forces the water out, and the jet acting against the still water beyond forces the scallop forward with a rapid

motion. Scallops are also noteworthy in being the fortunate possessors of numerous steel-black eyes.

The only part of the scallop eaten is the thick

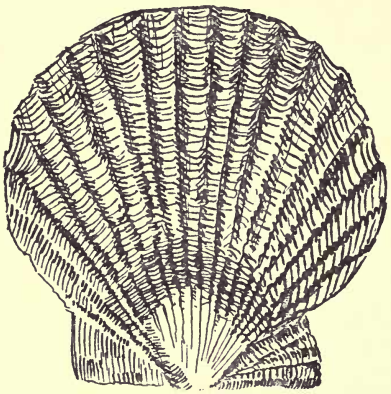

FIG. 28.—Scallop.

muscle which forms the body of the animal and holds the valves together.

Scallops seem to migrate in vast numbers, so that waters which teem with them this year may not furnish any a year hence.

SEA-MUSSEL.

The sea-mussel is not at all like the fresh-water mussel. The shell is of a dark blue or blue-black, marked with fine parallel marks. It is narrow and deep and lined with a thin layer of white, pearly

material. The most striking feature is the byssus or threads which the sea mussel thrusts out and fastens to rocks, stones, and other shells.

It is no unusual thing to find a dozen or more sea-mussels all joined in a tangled mass with gravel

FIG. 29.—Sea-mussel.

and other shells by means of these tough elastic fibres.

Sea-mussels attach themselves to piles and other timbers at high tide, and then they may be seen when the tide has gone out hanging high and dry above the beach.

Mussels are not very highly prized for food, but some people spice them in vinegar, and then they are regarded as a delicacy.

OYSTERS.

The oyster should not be studied until many other mollusks have been observed. It is an erratic form, and should therefore be studied, if at all, after the general features of normal mollusca are well known.

The oyster-shell varies greatly in shape and size. Large numbers of shells frequently are found growing together in masses. The outside shows many

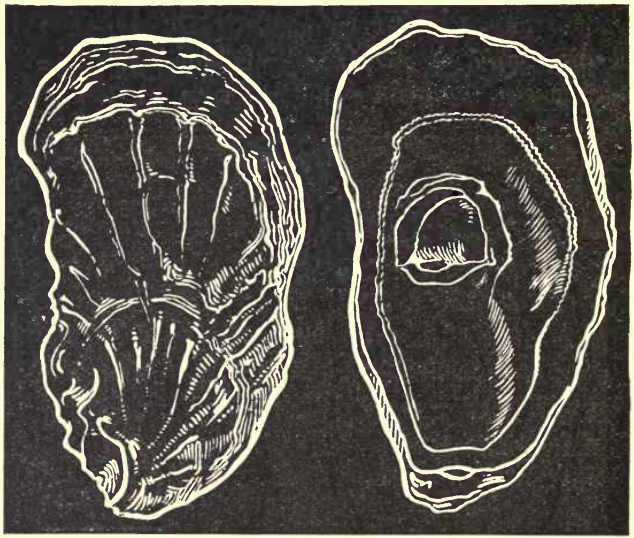

FIG. 30.—Oyster.

overlapping layers of calcareous matter. The hinge is small. The valves are very unlike in shape, one being larger and deeper than the other. Inside one sees only one large muscular impression.

PERIWINKLES.

Periwinkles are among the commonest shells washed on our shores Some are of a dull-gray

color and smooth, while others are of a delicate salmon hue and covered with a membrane. This skin is beset with fine fringes resembling the pile of velvet. Their eggs are among the most curious things washed up by the sea. The egg mass consists of a long string of flat, purse-shaped sacs, each of which contains a large number of tiny periwinkles.

Periwinkles are among the greatest enemies of the oysters, and oystermen take every precaution to destroy them.

RAZOR-SHELLS.

These are interesting mollusks on account of their peculiar shells, which are shaped very much like a razor. They burrow in the sand very much as clams do and are eaten by some people.

FIG. 31.—Razor-shell.

The shell is much more brittle than that of the clam. It resembles the mussel-shell in structure.

3. Other Creatures of the Water.

HYDRAS.

If the stones from the bottom of a fresh-water stream be examined closely, tiny patches of green

or red matter may be seen upon them. At first these may be mistaken for green-slime or a fungoid growth, but if watched for some time the mass will expand into a tiny funnel-formed shape, and closer examination with a magnifying-glass will show a circle of dainty tentacles around the upper side.

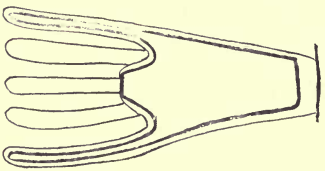

Fig. 32.—Hydra (Magnified).

If the vessel be given a slight jar, the tentacles will be drawn in and the whole creature assume its original shapeless form.

The base of the creature is called the foot. It acts like a sucker to hold the hydra in place. But the hydra is not by any means incapable of locomotion. If observed for a long time, hydræ will be seen to creep from one place to another. This creeping is a most interesting act. It is nothing else than a series of somersaults. The hydra first places his head (if one may say that a headless creature has a head) upon the stone near his foot and takes hold. Then it lets go with the foot and turns over. By repeating this act the hydra at length comes to the place where it desires to go.

The hydra belongs to a great class of creatures

which may be called radiates, because the parts of their bodies radiate from a centre.

Some Other Radiates.

The best-known radiate is the starfish. Its five strong, rough arms, its multitude of feet, its mouth

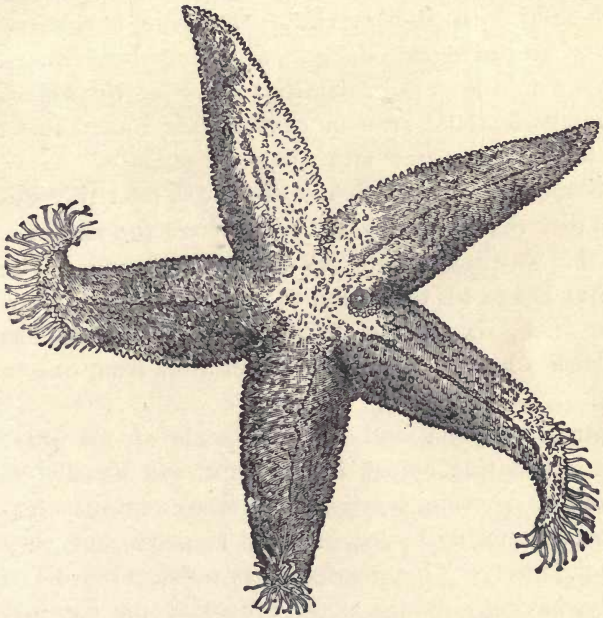

Fig. 33.—Starfish.

armed with five sharp teeth and its strainer are all easily found. Its manner of eating oysters is not so generally known. But oystermen recognize in the starfish the very worst enemy of their trade.

The starfish walks over the bottom on the tips of its pointed arms. On reaching an oyster whose shell is open the starfish projects its stomach out of its mouth, scoops the oyster from his shell, and devours him before he can close his valves. Many starfishes do not succeed in getting the oyster from his shell. In the inevitable struggle his brittle arms are in great danger of being broken off. This would be a sad calamity to one of the higher animals, but the starfish cannot care much about it, for in time a new arm will grow on.

Sometimes the starfish is broken so near the central disk that two arms will grow where the one was. In this way some monsters are often found. The writer has in his collection starfishes having three, four, five, six, and eight arms, and a friend has starfishes having every number of arms from one to ten.

Small streams and shallow pools of sea-water where the tide comes in and out will usually be found to contain polyps. These are curious creatures resembling hydræ in some respects, but very much larger. They consist of cylindrical masses of jelly, having a mouth at the centre of the top surrounded by many delicate feelers. If disturbed these curious animals at once contract into a shapeless mass of jelly. For the benefit of those who may want to preserve polyps the following recipe is submitted: Place the stone on which the polyp is

growing in a glass of sea-water. It will of course contract into a globular mass at first, but after a time it will expand to its full size and extend its thread-like tentacles. Then add a drop of magnesium sulphate solution, then another and another, very slowly, being careful not to jar the vessel. If done properly the creature will presently become paralyzed, with its body full size and tentacles extended. Then add a small quantity of chromic acid to kill the polyp.

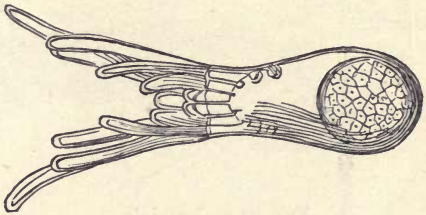

FIG. 34.—Polyp.

After the animal is dead, pour out about one-tenth of the sea-water and add the same amount of formaldehyde, or "formalin" as it is called, to preserve the specimen. Alcohol is just as good for preserving specimens, but it costs a great deal more.

4. **The Crayfish and his Cousins.**—The crayfish is so common as to need no extended description. The most conspicuous features are the huge front claws like pincers, the long feelers or antennæ, and the flat tail. The body is made up of joints or rings covered with hard horn-like substance. There are ten jointed legs, hence this family, to which

crayfish belong, is called decapoda, a word meaning ten feet. The gills are under the broad thorax-shell. The mouth is armed with a beak. The eyes are compound and stalked so that the crayfish can project them up and see in all directions.

The most interesting trait of this animal is his way of locomotion. He goes backwards rather

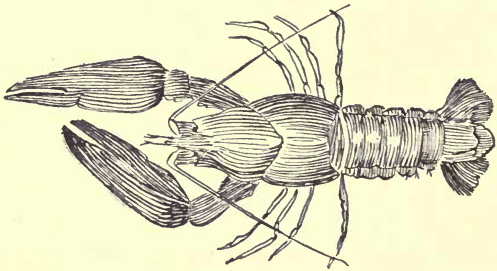

FIG. 35.—Crayfish.

than forwards by shooting himself through the water.

Every aquarium should have one or more crayfishes, but they are best kept by themselves, as they sometimes devour the other denizens of the aquarium. Crayfishes are usually quite abundant in small clear streams, where they may be caught creeping about among the stones on the bottom.

OTHER CRUSTACEANS.

There are many relatives of the crayfish, but most of them live in the sea. Among these are the

crab, the lobster, and the shrimp, so highly valued for food. But there are many others which are among the most curious inhabitants of the sea-shore. Among these are the fiddler-crab. One of its front claws is very large, while its mate is small. It thus gives him the appearance of a man playing a "fiddle." This crab lives in vast numbers near the seaside, where it burrows in the ground. The female has both front claws alike, and both are small.

The hermit-crab is also a very curious creature. It lives in the abandoned shells of sea-snails. When it grows too large to live in its borrowed house in comfort, it creeps out and seeks a larger shell. By living in a shell all the time the hind parts of the body become soft and unprotected by horny scales like those of its cousins.

The king crab, or horseshoe crab, is not really a crab at all. It is the sole descendent of a mighty race of creatures which once inhabited the waters of the earth—the trilobites. It has a smooth rounded horn-like shell in which are two huge compound eyes and two simple eyes. Underneath are six pairs of jointed legs. The body is tipped with a long needle-like spine.

King crabs are mostly nocturnal. They come along the shore as the tide comes in and devour all sorts of organic matter cast up by the waves.

Sand-fleas and water-fleas are tiny crab-like creatures which are often found in water and in wet

sandy beaches. They are easily caught, and if placed in a glass of clear water they may be observed for a long time.

In regard to preserving crustaceans it is well to know that most of these animals have the power of throwing off their legs if they are placed in alcohol or formalin suddenly. This is because these substances hurt them and produce a muscular contraction so violent as to break them at the joints. To prevent this it is better to let the water get slowly warm until it is so hot as to kill them. Then the preserving fluid may be added, and the specimen is ready for the collection.

NOTE.—Teachers who live inland too far from the sea to study marine life may spend a summer at the shore and then make a collection for use in school during the year. I would urge any and every such teacher to provide herself with a quantity of bottles and a supply of alcohol or formaldehyde and make a collection even if she does not contemplate making an exhaustive study of such things.

We have thus far studied a few creatures the whole of whose lives are spent in the water. They all grow from eggs, and they hatch out into forms like their parents. But there are other creatures whose early life is spent in the water, but whose mature life is spent in the air. It will be our purpose next to consider a few of these animals.

CHAPTER VI.

Metamorphosis.

NOT all creatures are perfect when first hatched. Very few come forth from the egg in perfect condition. The majority pass through a great variety of forms before they attain to the adult state.

We have considered some of these changes in the volumes of this series pertaining to insects, but metamorphosis is not confined to insects. With those creatures whose life is spent in the air we have nothing to do, but with those some of whose life-changes transpire in the water we have some concern.

It has been stated in another volume that insect life may be divided into four principal stages, i.e. egg, larva, pupa, imago. Now, insects whose early life is spent in the water are found to pass through the same stages, but in the larval stage they are called nymphs. Thus the water-insect is said to pass through the following stages: egg, nymph, pupa, imago.

With this last stage we have nothing to do, since

it is the stage after the creature has left the water. But with the stages spent in the water we may very properly concern ourselves.

In collecting material for the aquarium many living creatures will be found which do not belong to any of the types previously considered. These may be roughly divided into two classes, i.e. those having jointed bodies (nymphs) and those having soft more or less fish-like bodies (amphibians).

We will first consider a few of the nymph or larval forms.

1. **The Dragon-fly.** — The nymphs are easily recognized as insects. They have a three-parted

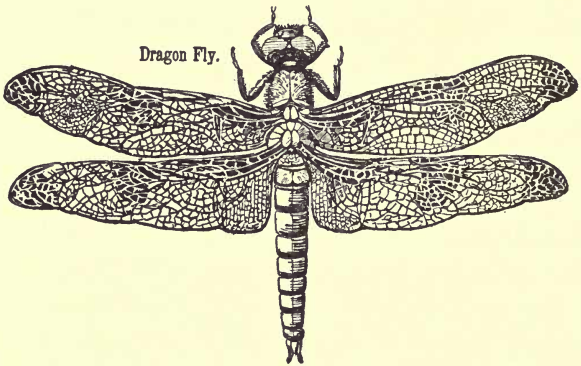

FIG. 36.—Dragon-Fly.

body (head, thorax, and abdomen), six legs, and prominent compound eyes.

The wings are not developed, but close observation will discover them folded away on the back

but concealed under the outer shell of the creature. They vary greatly in size and shape. Some have very stout bodies, powerful legs, and large heads, while others are long and slender with very long slender legs and abdominal appendages. Their mouths are large and have very large lower lips.

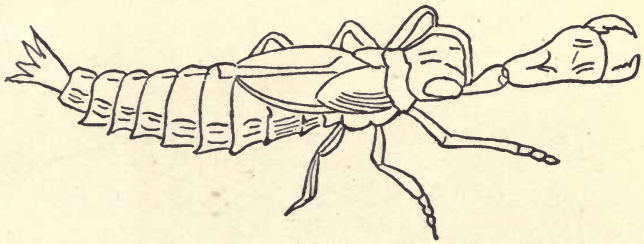

FIG. 37.—Dragon-Fly Nymph.

They shed their skins several times before attaining to their adult size. When full grown they crawl up the side of the aquarium, or better the stem of some plant growing therein, and having dried off somewhat they emerge from their skins by creeping out through a split down the back, very much as a man gets out of a shirt.

Nymphs are easily captured for the aquarium by drawing ashore submerged trash with a garden-rake. The nymphs will usually be found crawling around among the wet trash.

2. The Mosquito.—Wiggles are best bred in an individual aquarium made by dipping a tumbler or Mason jar part full of rain-water containing them.

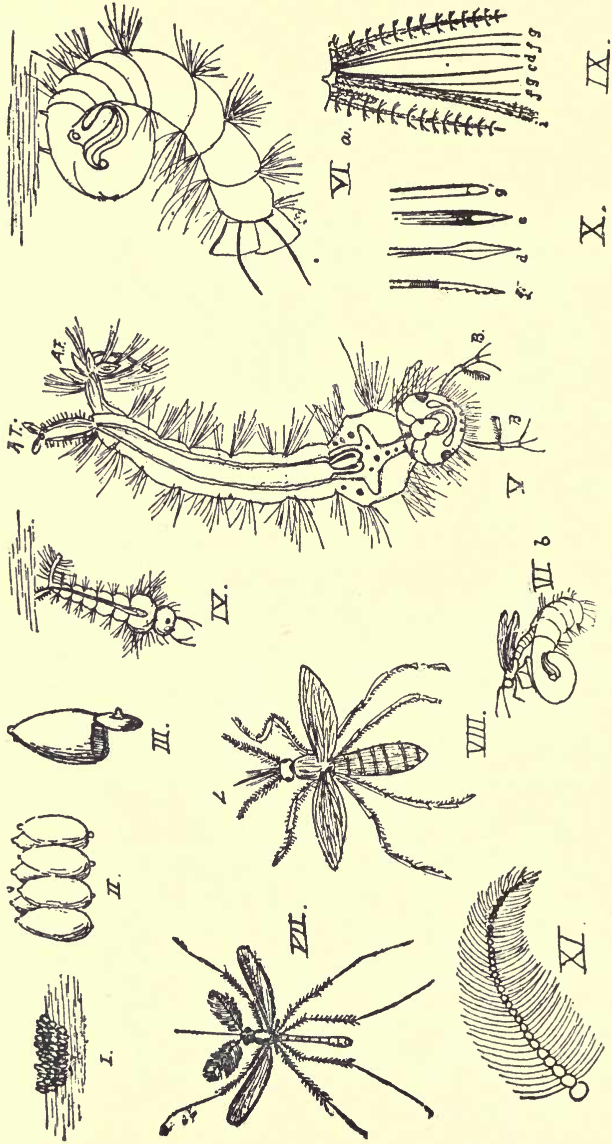

FIG. 38.—Mosquito.

If this improvised aquarium is kept covered with a piece of gauze or netting, the development of the mosquitoes may be studied from egg to imago.

In collecting larvæ of mosquitoes go to a convenient rain-water barrel or tub which contains them; look for the tiny egg-masses or rafts which may be found floating upon the surface.

The larvæ are interesting as they go wiggling hither and thither through the water, and the pupæ are not hard to recognize on account of their large heads and less active movements.

Mosquitoes, nymphs, and other insect larvæ cannot be bred advantageously in aquaria with fishes or indeed with each other, for the weaker invariably must succumb to the stronger. It is no uncommon occurrence to find many of the inhabitants missing after a few days.

3. **Stone-flies.**—These most interesting creatures are usually found in clear running water. They are so called because they live in cases made of tiny stones or sticks. These cases are often built with consummate masonry, the pebbles being selected with greatest care and cemented together with a secretion from the tiny creature. These cases are usually about $\frac{1}{2}$ to 1 in. long and $\frac{1}{8}$ to $\frac{3}{16}$ in. in diameter, open at one end, from which the legs, head, and antennæ may be seen projecting.

At first sight nothing is more interesting than to

see these dainty stone cylinders moving about over the bottom of a stream.

The stone-fly does not thrive well in aquaria unless the water is constantly changing. If the water becomes too warm or stale these creatures creep forth from their little homes and die.

When ready to leave the water, they creep out of their little shelters and crawl up the stems of some aquatic plant. In the air they soon dry off and the shell cracks down the back. Then the imago extricates itself very much as the dragon-fly does.

4. **The Dobson.**—Everybody has seen this hideous-looking creature, but he is better known as the

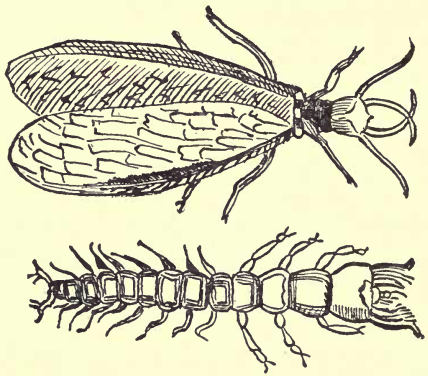

FIG. 39.—Dobson.

Hellgramite. To catch these curious animals procure a piece of thin soft cloth; mosquito-netting is the best. Take a piece perhaps one yard square

and go to some rocky brook where the water flows rapidly over the stones. Place the netting in the stream so that it will float out flat in the current. Lay some large stones at the upper corners so that the stream shall not carry it away. Then go up-stream a few feet or yards and begin turning over stones in the bed. Plenty of dobsons will be set free. They will be borne down-stream until they reach the mosquito-netting. Here they will be able to catch hold by means of their legs and mandibles. In the central States dobsons caught in this way are used as bait for bass.

The head is large, thorax conspicuous, and abdomen long, each ring being armed with two spines. The jaws are also large and powerful. The dobson is thus a very formidable enemy of the larvæ of stone-flies, may-flies, dragon-flies, and other water-loving insects.

With the pupa and imago states we have nothing to do. In the pupa state the dobson leaves the water and forms a burrow on the shore, where it remains for two or three weeks. Then it assumes the imago state, known as Hellgramite or long-horned corydalis, and flies away.

The imago is not seen often, because it is nocturnal in its habits, but it is readily recognized by its broad gray wings and long horns and antennæ, its prominent head and neck-like thorax.

5. **Water-beetles.** — No aquarium is complete without one or more water-beetles. These are very various and numerous. They may be recognized by their shining, smooth, shell-like elytra and their curious paddle-like feet. By means of

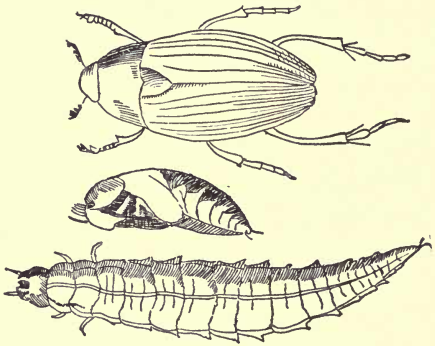

FIG. 40.—Water-beetle.

these paddles they are able to skim rapidly over the surface, and some species dive below and creep along over the bottom.

6. **Water-boatman.**—This is a hemipterous insect (bug) which circles about on the water. They are usually seen in great numbers, forming patches of silvery sheen, which move about with great rapidity. The hind legs are essentially similar to those of the water-beetles, being broad, paddle-like, and armed with a fringe of close-set hairs along their posterior margin.

7. The Ranatra.—The ranatra or scorpion-bug has been mentioned in No. 8 Manual of this series. It is one of the strangest creatures, having only four legs, used for walking and skimming over the surface, while the prolegs are wonderfully developed into organs fitted for seizing prey, like those of the scorpion and lobster.

CHAPTER VII.

Some Amphibians and Reptiles.

AMPHIBIANS are cold-blooded creatures which begin life as fishes, breathing by means of gills, but later in life they develop true lungs and become air-breathers. To this class belong newts, frogs, and toads.

1. **The Frog.**—The eggs are laid in masses consisting of clear, transparent jelly containing small spherical yolks scattered through it.

If kept in a vessel of fresh water these yolks will soon show the formation of a tiny fish-like body, which soon will be seen to move from time to time. At length the enclosing membrane breaks and the tadpole escapes from the egg-mass.

Tadpoles are of a dull-green color, and from the first they are very active. They resemble fishes in shape and motion, but show no signs of fins.

They grow rapidly, and at length show swellings on each side well back towards the tail. These at length open up, setting free a pair of legs. The same is repeated soon after on each side of the head, and a second pair of legs appears. The tail now begins to shorten. The substance seems to be absorbed by the body, and the outer parts slough off and drop away, leaving the creature

without any vestige of a tail. The tadpole has become a frog.

About the time when the legs are appearing the

FIG. 41.—Frogs.

tadpole frequently swims to the surface and swallows air. The gills are gradually disappearing as the lungs are developing.

2. The Toad.—The development of toads is exactly similar to that of frogs. The eggs are not laid in masses, as with frogs, but in strings of jelly having the yolks arranged uniformly along the strings. These yolks are black in toads, and toad-tadpoles are easily told by their black color.

When fully developed, toads leave the water and return to it only at spawning time.

3. Newts.—Newts pass through only a partial metamorphosis. They develop legs, but they do not lose their tails, and they never go far from the water. Newts frequent small streams, the outlets of springs, and wet, swampy localities. Unlike frogs and toads, they do not like stale water, and will die if the water is not kept perfectly fresh.

4. The Turtle.—The only reptile which is likely to find place in an aquarium is the turtle. Turtles

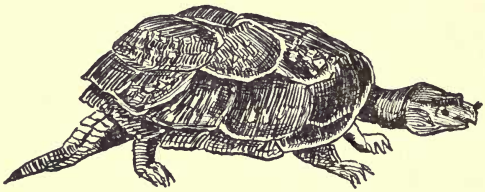

FIG. 42.—Snapping Turtle.

are too well known to need description here. Their shell-like covering and beak-like mouth, their scaly, clawed feet and bright, shining eyes have been recognized by every schoolboy. Let it not be forgotten that there are land-turtles as well as water-turtles, and it is cruelty to animals to place land-turtles, tree-toads, etc., in aquaria.

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